AD-A144 352 METEOROLOGICAL AND CLIMATOLOGICAL CONDITIONS AFFECTING THE VERTICAL STRUC..(U) HANOVER UNIV (GERMANY F R) INST FUER METEOROLOGIE UND KLIMATO.. R ROTH JUL 84 1/1

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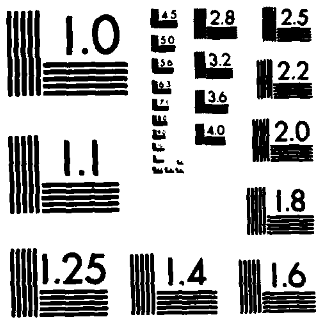

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Statistics are now complete for all of 1983. Data include frequency distributions of visibility for six height levels. The distributions show a maximum of about 10 km visibility at the 2 m level. With increasing height this maximum moves to a visibility range of about 40 km. Low visibilities are causes chiefly by fog in the 2 - 80 m levels, and by clouds in the 60 - 297 m levels.

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Meteorological and Climatological

Conditions Affecting the

Vertical Structure of Visibility

in Northern Germany

Principal Investigator: Prof. Dr. R. Roth
Name of Contractor: University of Hannover

Contract Number: DAJA 37-82-C-0189

F i f t h Interim Report

July 1983 - June 1984

The research reported in this document has been made possible through the support and sponsorship of the U.S. Government through its European Research Office of the U.S. Army. This report is intended only for the internal management of the Contractor and the U.S. Government.

Scientific work during the reporting period

The measured data are continuously processed, invalid data are eliminated and the data of the synoptic stations are added. This completion is up to date within a delay time of 1 - 2 months due to technical reasons.

For the time being statistics have be done for the whole year of 1983. For this time period frequency distributions of visibility were established for the six height levels. Typical differences can be recognized: The distributions show a maximum of about 10km visibility at the 2m level. With increasing height this maximum moves to a visible range of ≥ 40km at the levels of 153m - 297m. Another maximum is to be found at small visibilities which is mainly caused by fog (2m - 80m height) and by clouds (80m - 297m height).

For the same time period diurnal variations were plotted for different weather patterns and airmasses. The variations typically show a maximum of visibility between 12 - 17 MEZ. For most weather situations during nighttime visibility decreases at all heights showing a small vertical gradient (patterns with well mixed boundary layers). During radiation nights (high pressure over Middle Europe etc.), however, only the visible range at 2m and 9m height is reduced whereas it increases at the levels above so that the vertical gradient of visibility is intensified. Two typical diurnal variations are shown in the annex.

The vertical structure of visibility below stratus or stratocumulus clouds with ceilings of 150m - 350m and of about 1000m height had been investigated. For ceilings below 300m visibility continuously decreases with height. For ceilings of about 350m a relative maximum at 150m height can be recognized in the vertical structure. In the case that the cloud ceiling is in the range of 1000m height

the vertical structure of visibility increases with height up to the 300m level. It can be assumed that the visible range above will decrease with height after having reached a maximum value at a certain level. Its proper height is not detectable with the instrumentation used. St or Sc clouds with ceilings between 400m and 1000m are not to be found in the Sprakensehl data. Exemplary cases are shown in the annex.

In October 1983 two field experiments took place at Sprakensehl. In addition to the visibility measuring system a tethersonde package in accordance with the liftsystem and a monostatic sodar were used. During two nights (23/24 Oct 83 and 29/30 Oct 83) the change of the vertical structure of visibility due to effects in the nocturnal boundary layer could be studied. The additional measuring system as well as the registrations are described in the Second Interim Technical Report.

Plans for remainder of the contract

It turned out that different Großwetterlagen and airmasses partly show similar diurnal variations of visibility. Additionally it is dependent on the season and on the time of sunrise and sunset. For this reason Grosswetterlagen and airmasses of the same character will be summarized to avoid a too confusing number of cases. At the end there will be about 5 typical diurnal variations for the wintertime and the same number of variations for the summertime.

The investigation of the vertical structure below stratus and stratocumulus will be continued. Ceilings between 400m and 1000m have not been observed yet, so that those cases will be of a special interest.

Time dependent variations of the visibility profile (e.g. the formation of fog, rapid change in airmass) will be investigated soon. The frequency of the transition from one visible range to another will be related to the synoptic condition (passage of fronts) and the time of the day mainly important for high pressure with a large diurnal variation in temperature and humidity).

In the near future the typical vertical structure of visibility for corresponding typical synoptic weather pattern (low, high etc.) will be given using the composit technique to get the opportunity of visibility forecasts.

Until autumn 1984 additional measurements by means of the tethersonde package with lift system and the monostatic sodar are planned.

Personnel changes, Publications, Conference

In spring 1984 the initial period of warranty of the AEG for the visibility meters ended. As we got the impression during the last year that some of the hardware problems could be better handled by ourselves we did not conclude a maintenance contract with AEG. Now the maintenance of the visibility meters is done by the institute. For this reason Dipl.-Met. Friedhelm David has been additionally engaged since May 1984 to look after the instruments in co-operation with our technician Mr. Surkow. First experiences showed that quite difficult hardware problems could be solved in this way. Mr. David shall take part in the data processing as well.

For the next future two publications are planned. The first one will be a short contribution describing the visibility measuring system at the Sprakensehl site (Meteorologische Rundschau). The second one will be a case study of the night 29/30 Oct 83 during a period of intensive measurements. It deals with the vertical structure of visibility affected by fog formation at midnight which showed all characteristics of a sea breeze like front inland (Boundary Layer Meteorology). This case has also been described in the Second Interim Technical Report.

On 2-7 September 1984 Prof. Roth and Dipl.-Met. Pietzner will participate at the '11th International Conference on Atmospheric Aerosols, Condensation and Ice Nuclei' in Budapest/Hungary.

Annex

1 Diurnal variations

In the following two quite different diurnal variations are shown. Fig. 1 presents the variation for the Grosswetterlage TRW (trough over West Europe; weather: changeable, but not always unfriendly). This weather pattern occurred 33 times during 1983. At midnight the diurnal variation shows a strong vertical gradient (2m height: 5km, 297m height: 20km visibility). After sunrise convection begins so that the visible range at the lower levels (2m - 80m) increases and at the upper levels (153m - 297m) decreases until the vertical gradient becomes very small at noon due to convective mixing. At about 15 MEZ the visibility at all heights reaches its maximum value whereafter it becomes smaller at all heights. At about 19 MEZ the vertical gradient of visibility is intensified: The visibility at 2m up to 80m height decreases (increase of relative humidity) whereas the visibility above becomes larger due to the subsidence. This shape of diurnal variations is typical for long wave radiation during nighttime and convection during daytime.

Fig. 2 shows the variation for the Grosswetterlage TM (low over Middle Europe; weather: often nearly stationary, heavy precipitation). This weather pattern occurred 13 times during 1983. In contrast to Fig. 1 the vertical gradient of visibility is quite small. The minimum value of visibility ($\leq$5km) is reached at all heights between 3 MEZ and 6 MEZ, the maximum value ($\geq$20km) at about 16 MEZ. The vertical gradient of visibility during nighttime is positiv (visibility at 2m height is smaller than at 297m height); at daytime, however, it is negative, i. e. the upper levels are affected by low clouds.

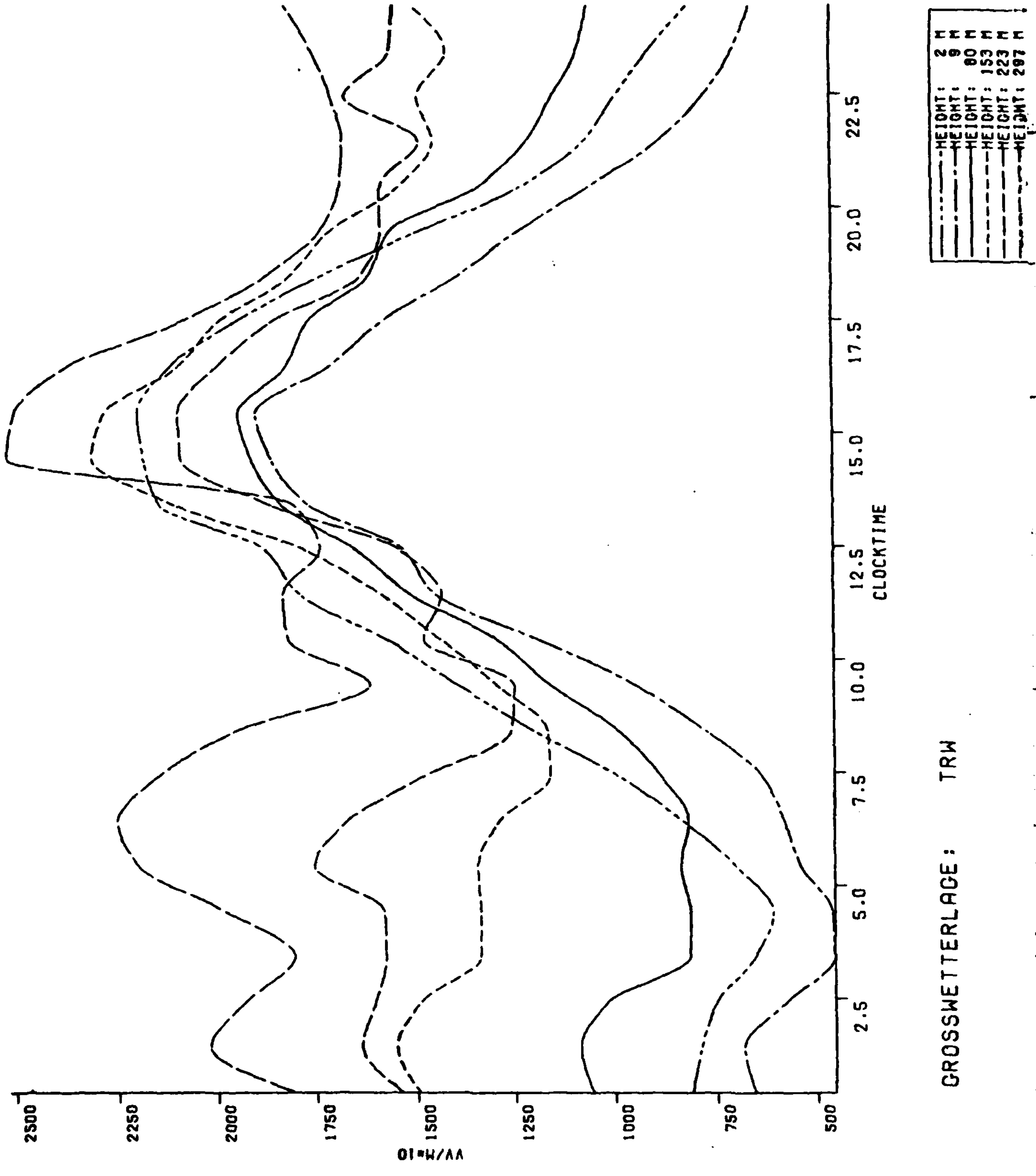

Fig. 1 Diurnal variation of visibility between 2m and 300m height for the Grosswetterlage TRW (trough over West Europe).

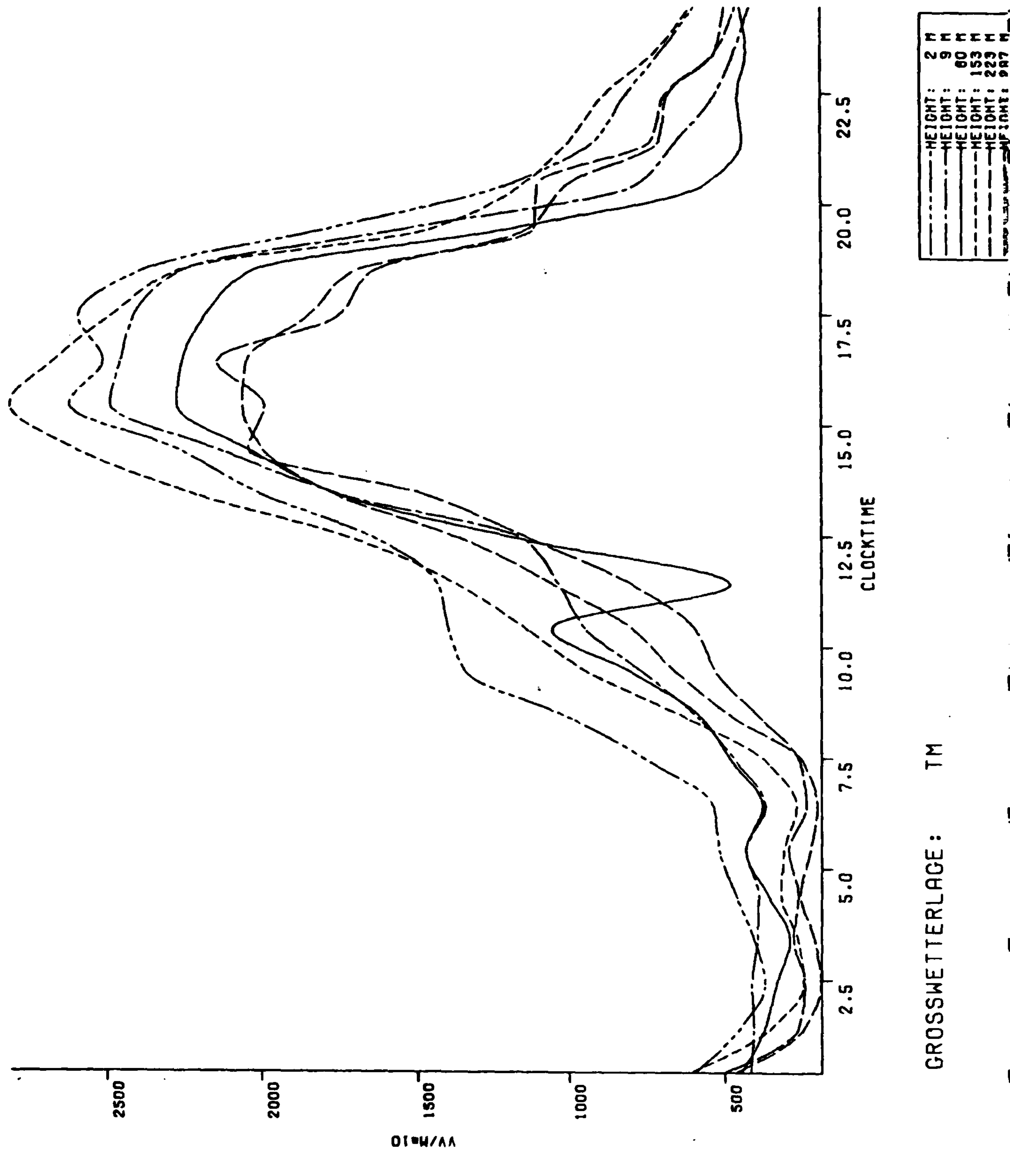

Fig. 2 Diurnal variation of visibility between 2m and 300m height for the Grosswetterlage TM (low over Middle Europe).

2 Vertical structure of visibility below St

The vertical structure of visibility below stratus clouds is shown in Fig. 3 and 4. The visibility (nomalized by the visibility at 2m height) is drawn versus the height (normalized by the ceiling). The curves in Fig. 3 represent the vertical profiles of visibility below a stratus with a ceiling of about 300m at two different days. Both profiles show a decrease of visibility from the height of 9m up to 297m. A different structure is to be seen in Fig. 4. Here the cloud ceiling is about 1000m. The visibility increases until it exceeds the measuring range of the visibility meters of 40km at 223m height. It can be assumed that the visibility will become smaller at higher levels between the height of 297m and the cloud ceiling.

In the latter case the maximum of visibility probably depends on the aerosol condition of the air mass. The behaviour described above may be typical for polar and arctic air masses which arrive in Northern Germany from the North, i.e. via the North Sea.

One very remarkable case was observed on 4 July 84 when over Scandinavia visibility near the ground was larger than 70km even for a spread ($T-T_d$) of 1K. For this case a synoptic chart is added as well as our own visibility measurements.

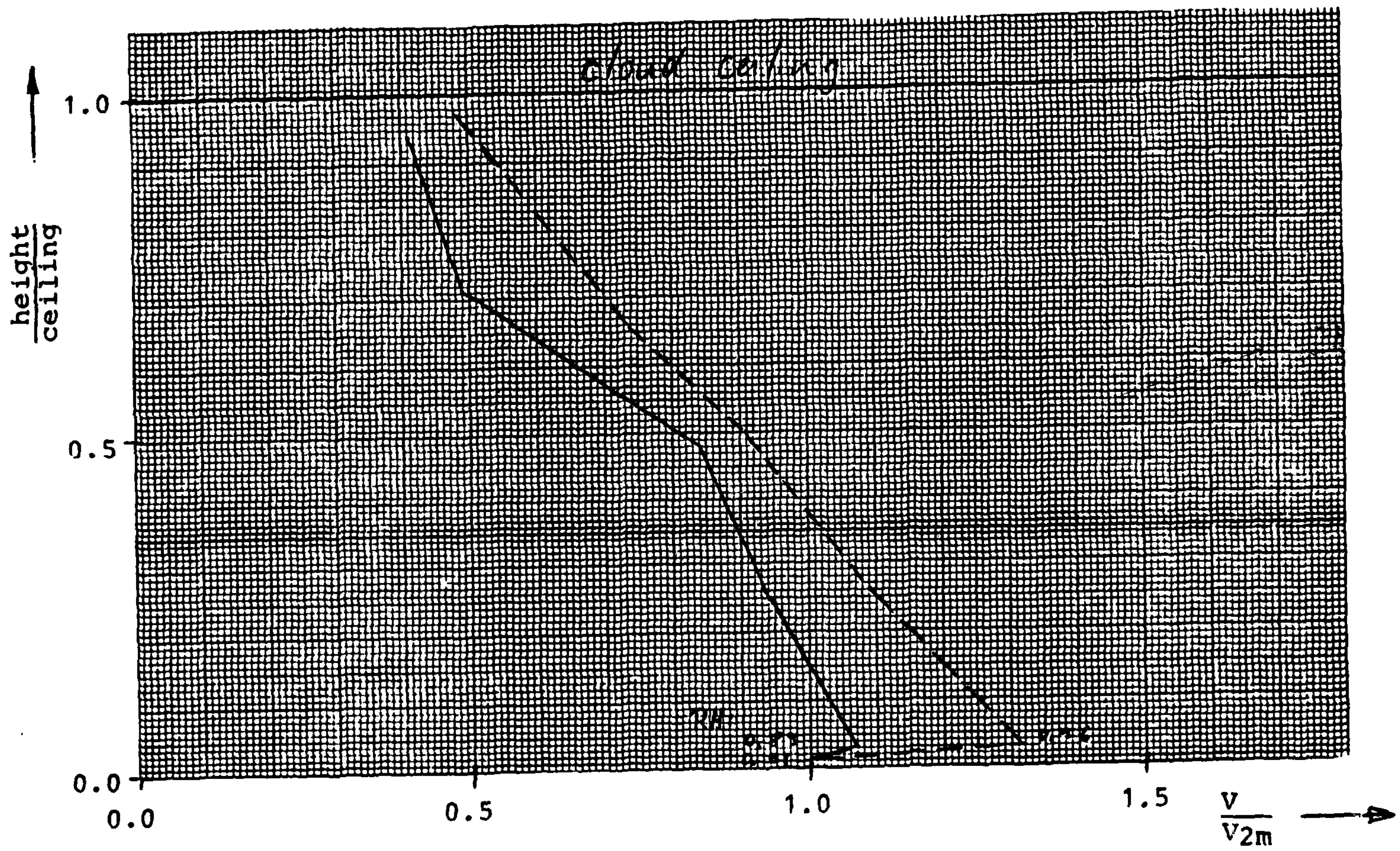

Fig. 3 Vertical profile of visibility below stratus
——— cloud ceiling 315m. 14 Feb 84, 22.00 MEZ
- - - - cloud ceiling 303m. 3 Feb 84, 16.10 MEZ

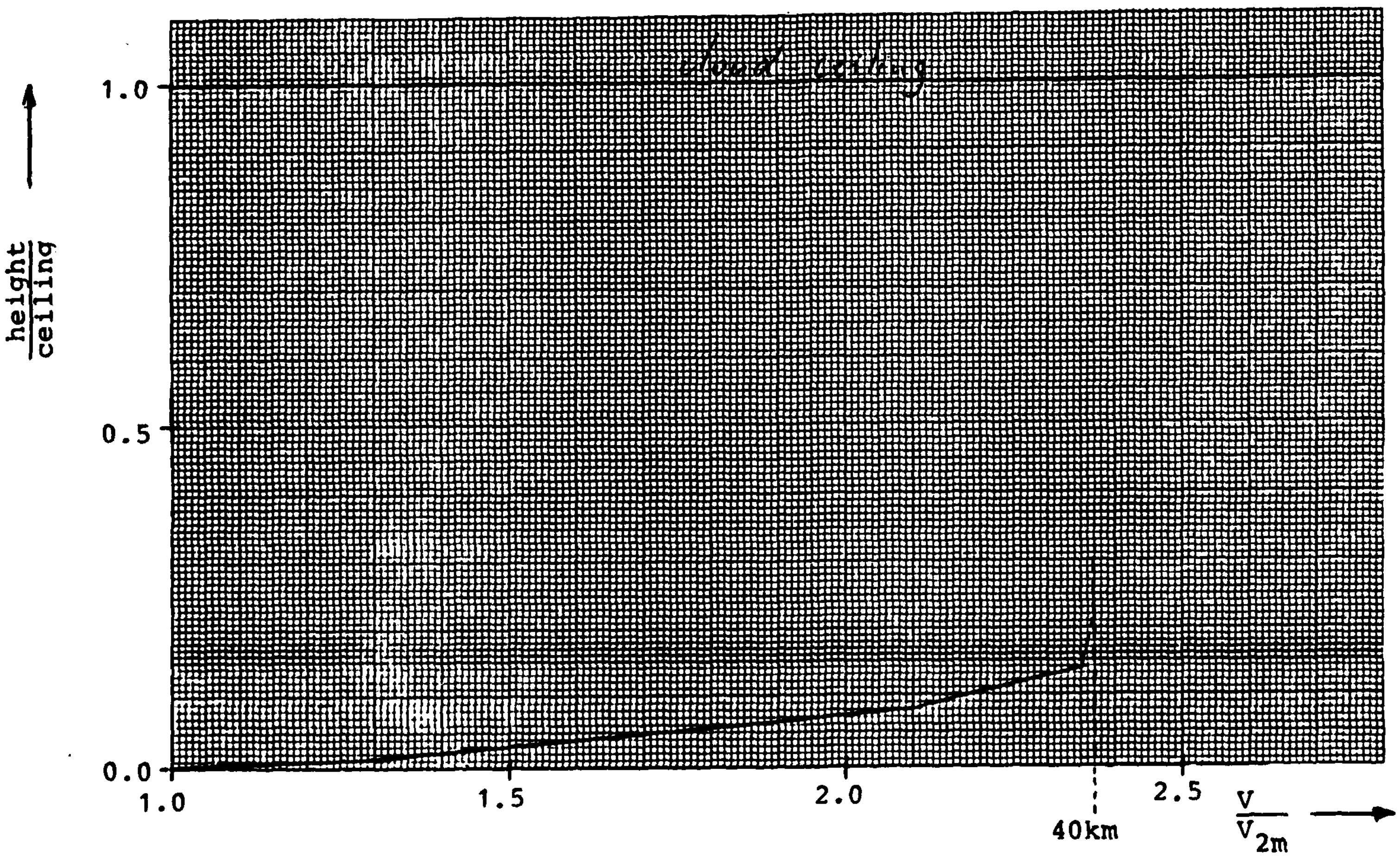

Fig. 4 Vertical profile of visibility below stratus cloud ceiling 1055m, 23 Oct 83, 2.00 MEZ

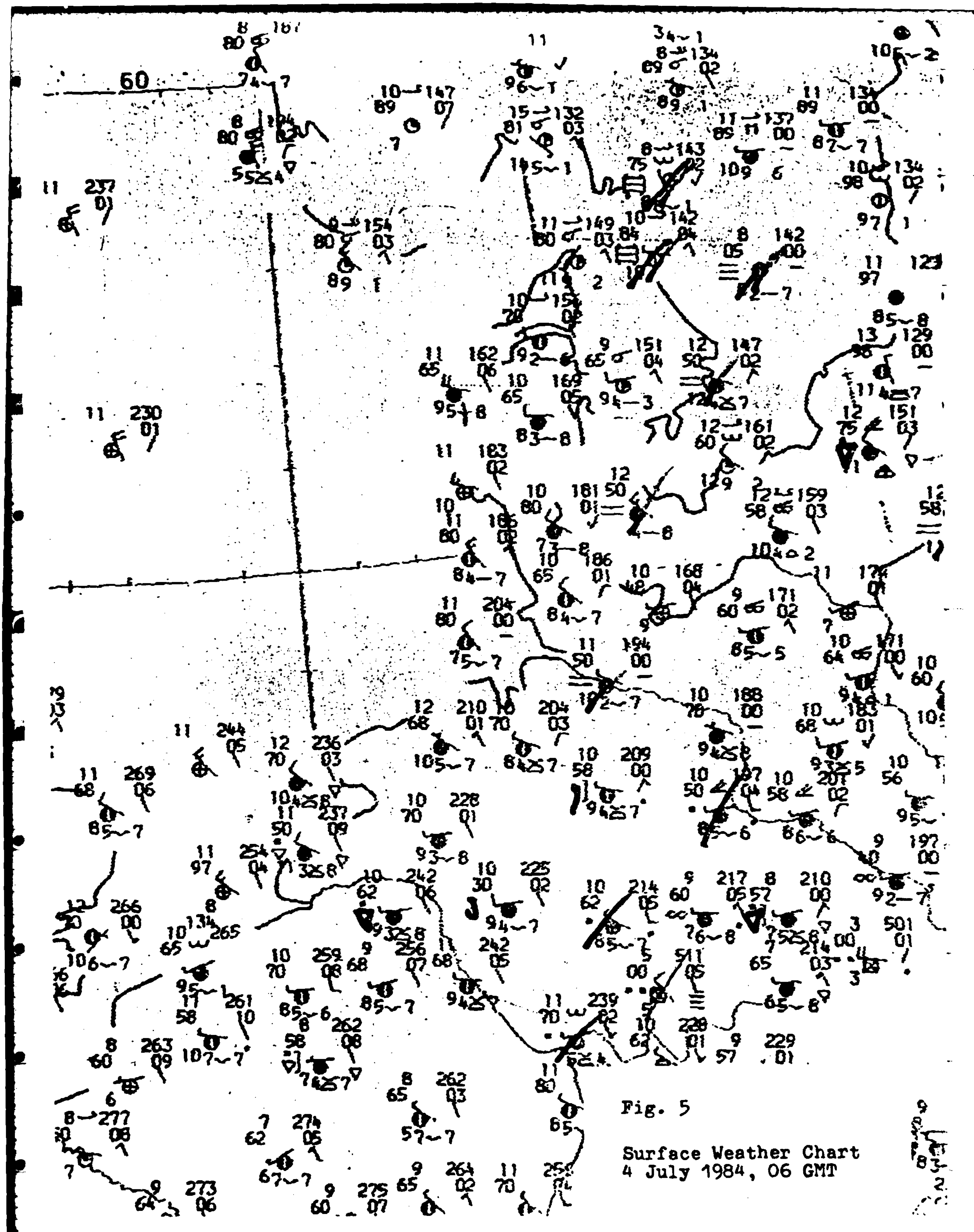

Fig. 5

Surface Weather Chart
4 July 1984, 06 GMT

	2m	9m	80m	153m	223m	297m
	810	407	8426	381	335	440
Visibility mean	3131	3676	2123	2379	1926	1089
(in km*100)	26	26	26	26	26	26
	3027	3585	1976	2094	1578	15
	3332	3907	2291	2503	2406	1883
	6119	6109	5945	5953	5853	5734
	6014	5943	5905	5907	5875	6032

Tab. 1

Sprakensehl data set, 8.10 MEZ, 4 July 84

code	visibility (km)
00	below 0.1
01	0.1
.	.
.	.
50	5.0
51 - 55	not used
56	6
57	7
.	.
.	.
80	30
81	35
82	40
.	.
.	.
88	70
89	larger than 70

Tab. 2

Code of visibility for most synoptic stations

Summary

There are no serious hardware problems. All instruments were recalibrated and some hardware failures were repaired. The software for the statistical analysis was developed and the further treatment of the data was discussed with Dr. M. Heaps in detail. For the time being the contract is in schedule. As discussed with Dr. Heaps some further investigations could be added which might result in the necessity of prolongating the contract for two further months as far as the expenses for personal are concerned.

END

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